MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2017/2018

PPH 0125 – MECHANICS
(All sections / Groups)

27 OCTOBER 2017
3.00 p.m - 5.00 p.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 3 pages excluding the cover page and the appendices with **FIVE** questions only.
2. Attempt **ALL** questions. Distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. All necessary workings must be shown.

Answer **ALL** questions.

Question 1: [10 marks]

a) With moment of inertia of 0.25 kg.m^2, a bicycle wheel is known to slow down from 300 rpm to 100 rpm in 1.5 minute due to its pivot's internal frictional torque. Calculate the external torque required to accelerate it from zero to 500 rpm in 60.0 s.

(6 marks)

b) An old disc record player has a disc-shaped turntable of radius 330.0 cm and mass 1000.0 g. The moment of inertia of this turntable is $0.5mr^2$ where m and r are the mass (in kilogram) and radius (in meter) respectively. The turntable is given a push to rotate at a constant angular speed of 45 rpm (assume negligible friction). Then, an old venyl record disc of moment of inertia 4.5 x 10^{-3} kg.m^2 is dropped onto the rotating turntable and subsequencly driven to the same angular speed as the turntable. What is the new angular speed of the combined bodies of turntable and venyl record disc?

(4 marks)

Question 2: [10 marks]

An object of mass, M = 2.0 kg, is attached to a spring of spring constant k = 50 N/m which is compressed a distance d = 20 cm and then released from rest. Assume that the mass is moving on a horizontal, frictionless surface.

a) Find the speed of the object when it has gone past the equilibirum point and is being *stretched* further a distance of 10 cm.

(2 marks)

b) Write an equation for the position of the object as a function of time, with t = 0 being the instant that the mass was first released from rest. Use this equation to find out how long it takes the mass to get from the initial point (release point) to the point where the spring is stretched by 10 cm.

(5 marks)

c) Write an equation for the velocity as a function of time, using the same definition of t = 0 as in part (b). Use this equation to find the velocity (magnitude and direction) when the time is $t = 3T/4$ where T is the period of motion of the mass on the spring.

(3 marks)

Continued...

Question 3: [10 marks]

A 30.0-kg block is released from rest at a point (O) on top of a smooth incline as shown in Figure Q3. It gains its velocity when sliding down for 2.0 m, reaching at the bottom of the incline and continue to move on the horizontal platform of coefficient of friction 0.15. If the horizontal platform is 5.0 m in length, will it fall at the edge of the platform?

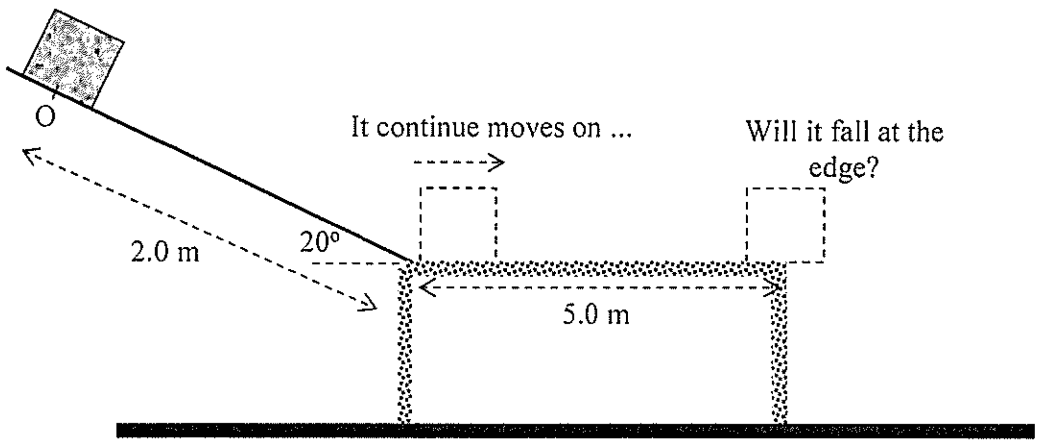

Figure Q3 (10 marks)

Question 4: [10 marks]

a) A small object of mass m is launched from the surface of the Earth with a speed of v_o in a direction perpendicular to the Earth's surface.

i. Find an expression for the speed v of the object at a height $h = R_e$, in terms of v_o, the radius of the Earth R_e, the mass of the Earth M_e, and the gravitational constant G.

(2 marks)

ii. Calculate the minimum value of v_o that will allow the object to reach the height h.

(2 marks)

iii. Now consider a different situation where the object is placed in a circular orbit at a height $h = R_e$. Find the velocity the object needs, in order to be in a circular orbit at that height.

(2 marks)

b) A coordinate system (in meters) is constructed on a table, and three objects are placed on the table as follows: a 2.0-kg object at the origin of the coordinate system, a 3.0-kg object at (0, 2.0), and a 4.0-kg object at (4.0, 0). Find the resultant gravitational force exerted by the other two objects on the object at the origin.

(4 marks)

Continued...

Question 5: [10 marks]

a) A rectangular wooden block of weight W floats in water with exactly one-half of its volume below the waterline. When a 20.0 g mass is placed on top of the wooden block, the top of the wooden block is leveled with the waterline. Given that density of water is 1.00 g/cm^3,

i. what is the mass of the wooden block?

(3.5 marks)

ii. The wooden block is removed from the water bath and placed in an unknown liquid. In this unknown liquid, only one-third of the wooden block is submerged. What is the density of the unknown liquid?

(2.5 marks)

b) A U-tube open at both ends is partially filled with water. Oil is then poured into the right arm and forms a column L = 5.00 cm high as shown in Figure Q5. Determine the difference h in the heights of the two liquid surfaces. Density of water = 1000 kg/m^3 and density of oil = 750 kg/m^3.

(4 marks)

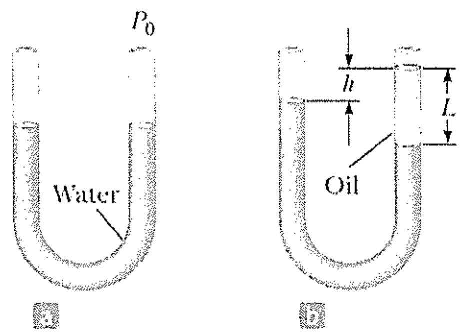

Figure Q5

End of Paper

APPENDIX I

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass,	m_p	1.67×10^{-27} kg
Elementary charge	e	1.602×10^{-19} C
Gravitational constant	G	6.67×10^{-11} N.m^2/kg^2
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_o	-13.6 eV
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Compton wavelength	λ_c	2.426×10^{-12} m
Planck's constant	h	6.626×10^{-34} J.s
Speed of light in vacuum	c	3.0×10^{8} m/s
Rydberg constant	R_H	1.097×10^{7} m^{-1}
Acceleration due to gravity,	g	9.81 m /s^2
Atomic mass unit (1u)	u	1.66×10^{-27} kg
Avogadro's number	N_A	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing	I_o	1.0×10^{-12} W /m^2
Coulomb constant	k	8.988×10^{9} N m^2 /C^2
Permittivity of free space	ε_o/κ_o	8.85×10^{-12} C^2/N.m^2
Permeability of free space	μ_o	$4\pi \times 10^{-7}$ H/m

Energy equivalent of atomic mass unit:
One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

Earth:
- Gravity = 9.81 m s^{-2}
- Radius = 6.38×10^{6} m
- Mass = 5.98×10^{24} kg

Moon:
- Mass = 7.35×10^{22} kg
- Radius = 1.74×10^{6} m

Sun:
- Mass = 1.99×10^{30} kg
- Radius = 6.96×10^{8} m

Mean distance from:
- Sun to Earth = 1.50×10^{11} m
- Moon to Earth = 3.85×10^{8} m

APPENDIX II

List of Formulas

$y = kx^n$ $\dfrac{dy}{dx} = knx^{n-1}$	$\sin\theta = \dfrac{\text{opposite}}{\text{hypotenuse}}$ $\cos\theta = \dfrac{\text{adjacent}}{\text{hypotenuse}}$ $\tan\theta = \dfrac{\text{opposite}}{\text{adjacent}}$

$v = v_o + gt$ $\quad y - y_o = v_o t + \frac{1}{2}gt^2$ $\quad v^2 = v_o^2 + 2g(y - y_o)$ $\quad y - y_o = \left(\frac{v_o + v}{2}\right)t$

$a_c = \frac{v^2}{r}$ $\quad F_g = G\frac{m_1 m_2}{r^2}$ $\quad U_g = -G\frac{m_1 m_2}{r}$ $\quad T^2 = K_s r^3$

$\tau = r \times F$ $\quad \sum\tau = \tau_{net} = I\alpha$ $\quad I = \sum mr^2$ $\quad v = r\omega$

$L = r \times p = I\omega$ $\quad K = \frac{1}{2}I\omega^2$ $\quad |\tau| = |r||F|\sin\theta$

$T_s = 2\pi\sqrt{\frac{m}{k}}$ $\quad T_p = 2\pi\sqrt{\frac{l}{g}}$ $\quad T = \frac{2\pi}{\omega} = \frac{1}{f}$ $\quad \bar{y} = \frac{\sum_{i=1}^{N} m_i y_i}{\sum_{i=1}^{N} m_i}$

$x = A\cos\omega t$ $\quad x = A\sin\omega t$

$v = -\omega A\sin\omega t$ $\quad v = \omega A\cos\omega t$ $\quad W_F = |r||F|\cos\theta$

$a = -\omega^2 A\cos\omega t$ $\quad a = -\omega^2 A\sin\omega t$

$v = \frac{\Delta x}{\Delta t}$ $\quad a = \frac{\Delta v}{\Delta t}$

$v = v_o + at$ $\quad x - x_o = v_o t + \frac{1}{2}at^2$ $\quad v^2 = v_o^2 + 2a(x - x_o)$ $\quad x - x_o = \left(\frac{v_o + v}{2}\right)t$

$W = mg$ $\quad \sum F = F_{net} = ma$ $\quad f_s \le \mu_S F_N$ $\quad f_k = \mu_K F_N$

$p = mv$ $\quad \sum F = \frac{\Delta p}{\Delta t}$ $\quad \Sigma W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ $\quad m_1u_1 + m_2u_2 = (m_1 + m_2)\,v$ $\quad P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$

$K = \frac{1}{2}mv^2$ $\quad PE_s = \frac{1}{2}kx^2$ $\quad F_s = -kx$ $\quad PE_G = mgy$

$\bar{x} = \frac{\sum_{i=1}^{N} m_i x_i}{\sum_{i=1}^{N} m_i}$ $\quad W_{Fs} = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$